#### PROBE CARD

### Background of the Invention

[0001] 1. Field of the Invention

5

10

15

20

25

30

35

[0002] This invention relates to a probe card, especially to a probe card to connect electrically between semiconductor measuring apparatus and IC pads.

[0003] 2. Description of the Prior Art

[0004] In the manufacturing process of semiconductor integrated circuit, after the end of diffusion process, by semiconductor measuring apparatus (tester), the electrical characteristics are measured in the state of wafer. In this tester, as a board to connect electrically IC pads (electrodes) with the tester itself, a probe card is provided. The probe needles furnished in this probe card are contacted to IC pads in order to connect to IC electrically.

[0005] The conventional probe card is comprised of printed circuit board, probe needles, resin to fix needles, upper guide plate, lower guide plate and fixing frame. A print circuit board connects probe needle to the measurement device itself electrically. The top end of probe needle is connected to wirings on the print circuit board with soldering. The lower end of the probe needle is the tip to touch a pad. At the center of probe needle, there is a curving part to buffer contact pressure toward the pad. Resin to fix needles fixes probe needle under the print circuit board. The upper and lower guide plates guide probe needles by guide holes to pass through probe needles. The fixing frame is fixed to the print circuit board and fixes the needle-fixing resin and the upper and lower guide plates parallel to the print circuit board.

[0006] When the wafer is measured, moving the wafer stage within its plane, after the position and

the direction are fitted, the stage is lifted to contact the tip of the probe needle to the pad on the surface of the wafer. But the electrical resistance of the contact is large because natural oxide film sticks to the surface of the pad as the waver is exposed in the atmosphere. It is necessary to expose the metallic surface of the pad in order to connect the probe needle electrically to the pad breaking through the natural oxide film by the probe needle. Therefore, after contacting the pad with probe needle once by raising the stage, furthermore, the stage is raised again. In this way, electrical contact is satisfied because the oxide film on the surface of the pad is scraped by probe needle.

10

15

20

25

30

[0007] By the way, there are two types of probe card. The probe card of the first type is of the cantilever type, wherein the probe needle comes out of the baseboard in the side oblique direction. The probe card of the second type is of the vertical needle type, wherein the probe needle comes out of the baseboard in the vertical direction. In the case of the cantilever type, probe needle can scrape an oxide film easily d sliding on the pad according to the rise of the stage because the probe needle comes out of the board obliquely. In the case of the vertical needle type, contact defect is often caused because the oxide film stuck to the surface of the pad cannot be removed. The probe needle hardly slides on the pad as the probe needle contacts vertically to the pad. In order to solve this problem, in "Semiconductor device measurement device" disclosed in the US patent application 2001-0028255, the oxide film stuck to the surface of the pad is removed by turning probe needles.

[0008] As shown in Figure 9, in this semiconductor measuring apparatus, the rotating guide plate 3 of

insulator is arranged between the upper guide plate 2 Insulator is arranged between the upper guide plate 4. The driving nart 13 of each and the lower guide plate 3. The curving nart 13 of each the rotation mide plate 3. and the lower guide plate 3. The curving device b moves the rotating guide rotated to the rotation the rocating guide place 3. The curving part 13 of the fixed direction with the fixed direction with the rotation with the rotation with the probe needle suite had not an arrange the mide to the rotation with the probe needle suite had not an arrange the mide to the rotation with the rot probe needle 5 is rotated to the rotating guide plate the rotating guide hole 12 of the rotating arming arm through the guide note 12 of the driving device 6 holds
the shown in Figure 70 tation mide night 2 hor representation mide night 2 hor representat 3. As snown in Figure 9(a), the arm. The driving guide plate 3 by the arm.

the both ends of the rotating guide 9(h) receiving the both arise as enound in Figure 9(h). the both ends of the rotating guide plate 3 by the street of the rotating guide plate 3 by the receiving in Figure 9(b), receiving the both drive, the driving device of the plate 3 by the rotating guide g when to arive, as shown in Figure 9(D), receiving device 6 moves the driving device 6 moves the electric signal, are 2 2 2 the mide have a receiving electric signal, the driving device 6 moves the the driving device 6 moves the la revolves the guide hole 12 revolves the driving device 6 moves the lateral signal, the driving device 6 moves the lateral signal signal, the driving device 6 moves the lateral signal sig rotating guide plate 3 as the guide noie 12 revolves the rotating guide plate 3 as the probe needle 5. In this way in the around the axis of the probe needle 5 incorred in the around the axis of the probe needle 5. around the axis of the probe needle 5 inserted in the curving part 13 of the rotation mide niate 3 is forced curving part 13 of the prope needle 5 inserted in the prope needle 5 inserted in the guide plate 3 is forced a fine for the rotating guide plate 3 is forced a fine for the north needle 5. Inserted in the guide hole 12 of the rotating guide hole 12 of the remarkant the axis of the north needle 5. Inserted in the guide hole 12 of the rotating for the north needle 5. Inserted in the guide hole 12 of the rotating guide hole 12 guide note 12 of the rotating guide plate 3 15 forced As the probe needle 5. As the needle for the axis of the probe rotate on the to revolve the lower for of the recent that the recent t to revolve centering the axis of the needle rotates on the lower the lower the nad in hreaking the rotates the result, contacts to the nad in hreaking the nad in hreaking the rotates to the result, contacts to the nad in hreaking the nad in hreaking the rotates to the nad in hreaking the rotates to the nad in hreaking the rotates to the nad in hreaking the nad in the result, the lower top of the pad 10 breaking through the pad 10 and contacts to the pad 10 arresponding the pad 10 and contacts armak on the pad 10 and contacts armak on the pad 10 and contacts armak on the contacts are contacts. pad 10 and contacts to the pad 10 breaking through the pad.

The pad 10 breaking through the pad.

The pad 10 breaking through the pad.

The surface of the pad. al oxide film stuck on the surface of the pad.

[0009] However in the conventional probe card, 10 there is a problem that the pad and vamp are there is a proplem that damaged. In make and microrial unnecessarily damaged. unnecessarily damaged. Dispersions of neight and of neight and Dispersions of neight and necause the needle. Dispersions of neight and necause the needle needle. Dispersions of neight and necause the needle needle. Dispersions of neight and necause the needle needle needle necause the necause the needle need position surely exist in prope easily caused because the movement are easily enring the form and the propegator of the propeg the rorm and the movement are easily caused because to be a spring. Therefore, probe needle is processed to be a spring. probe needle 1s processed to be a spring. Therefore to some probe needle applies annies annie 15 some prope needle applies unnecessarily strong returns the pad, some proper records and many arms of the pad, some property and propert the pad, some probe the pad. The strong probe needle applies only minimum along the pad. The pad along the necessary torce to the pad. The strong prope needle there injures the pad with the strong aifficult in the injures the pad with the strong aifficult in the injures the pad with the strong injures the pad with the second industrial in the pad with the pad with the strong aifficult in the case injures the pad with the second industrial in the pad with the strong prope needle injures the pad with the strong torce. And also there is a problem that assembling is difficult in the curving national and a problem that assembling to the control of the curving national and the case with the case wit with the case with the case with the case with the case with th is a problem that assembling is difficult the curving part rotated with the curving part of the probe needle being rotated with needle is of the probe medie nitch of the north needle is 20 or the prope needle peing rotated with the curving of the prope needles is in the center. The pitch of the prope needles in the center. In the center. The pitch of the curving part. or the size of the narrow nirch or restricted by restricted he annied to the card cannot he annied to restricted by the sapplied to the narrow pitch pad. cannot be applied to the present invention is to the present invention in the object of the present in the object of luulul The object of the present invention is to the present invention in the present invention is the present invention in the present invention is the present invention in the present of integrated circuit without and the present invention is the present invention in the present in the present invention in the present invention in the present invention in the present in th 25 enable the measurement or integrated circuit without by diameter on the pad by damage larger than the needle diameter on the pad by 30

35

contacting the probe needle to the pad of wafer with the uniform needle pressure in the probe card of semiconductor measuring apparatus by solving the abovementioned problems of the last.

[0011] To solve the above-mentioned problem, in the present invention, the probe card is comprised as follows: an electrically-conductive linear probe needle whose bottom end contacts with the device under test, a circuit board with which the upper end of the probe needle is connected electrically, an upper guide plate held horizontally and firmly near the middle point between the upper end and the center of said probe needle and having a guide hole to guide said probe needle, a lower guide plate held horizontally and firmly near the middle point between the center and the bottom end of said prove needle and having a guide hole to guide said probe needle, a rotary guide plate held horizontally and movably near the center of said probe needle and having a guide hole to guide said probe needle, an initial-position holding means to hold said rotary guide plate temporary and firmly at the initial position where said probe needle is straight, a movable holding means to hold movably said rotary guide plate at the position where the center of said probe needle bent, a driving means to move said rotary guide plate in the horizontal plane.

[0012] Measurement can be done without damage larger than the needle diameter on the pad of wafer by preventing the dispersion of the pressure of probe needle. The probe card can be applied to the integrated circuit of narrow pitch pad as the probe needle is straight. Assembling of the probe card becomes easy.

5

10

15

20

25

### Summary of the Invention

[0013] In the probe card of the semiconductor device measurement device, measurement is to be done in the stability without damage beyond the needle diameter 5 on the pad of the wafer by the probe needle. The straight probe needle 5 is inserted in the upper guide plate 2, the rotary guide plate 3 and the bottom guide plate 4. The rotary guide plate 3 is a little displaced, and the center of the probe needle 5 is 10 bent. Under this condition, the stage with the wafer thereon is raised, and then the tip of the probe needle 5 reaches the pad on the surface of the wafer. The rotary guide plate 3 has a guide slot 7. The rotary guide plate 3 is moved in the horizontal plane. The 15 fixed guide pin 8 moves along the guide slot 7. The probe needle 5 rotates like swinging. The probe needle 5 breaks through the natural oxide film stuck on the pad. In this way, the dispersion of the pressure of the probe needle 5 is prevented. Measurement can be done 20 without damage beyond the needle diameter on the pad of the wafer. Moreover, the pitch of the probe needle 5 can be narrow, and assembling becomes easy. The probe card of this invention is the most suitable as a probe card to make the electric connection with the pad of 25 the semiconductor device measurement device itself and the IC. The subject matter of the present invention is particularly pointed out and distinctly claimed in the concluding portion of this specification. However, both the organization and method of operation, together with further advantages and objects thereof, may best 30 be understood by reference to the following description taken in connection with accompanying drawings wherein like reference characters refer to like elements.

## Brief Description of the Drawings

[0014] Figure 1 is the disassembled oblique view of probe card of the first embodiment of this invention.

5 [0015] Figure 2 is the side view of the initial condition of probe card of the first embodiment of this invention.

[0016] Figure 3 is the side view of the drive condition of probe card.

10 [0017] Figure 4(a), 4(b) and 4(c) comprise the plan view of the rotary guide plate of the probe card and the illustrative figure of rotation.

[0018] Figure 5 is the side view of the probe card with the stepped-stage in working.

[0019] Figure 6(a) is the disassembled oblique view of probe card of the second embodiment of this invention. Figure 6(b) is the cross section of eccentric bearing.

15

20

25

30

35

[0020] Figures 7(a), 7(b) and 7(c) show the plan view of the rotary guide plate of the probe card and the illustrative figure of rotation.

[0021] Figure 8(a) is the disassembled oblique view of probe card of the third embodiment of this invention. Figure 8(b) is the cross section of eccentric bearing.

[0022] Figure 9(a) and 9(b) are the side view of the probe card of the prior semiconductor device measurement device.

# DETAILED DESCRIPTION OF THE INVENTION

[0023] Hereinafter, the most preferable embodiments of the present invention are explained in detail referring to Figures 1 - 8.

[0024] The first embodiment of the present invention is the probe card, wherein the straight probe needle is inserted through the upper guide plate, the

rotary guide plate and the lower guide plate, the center of probe needle is bent by moving the rotary guide plate in the horizontal direction and the probe needle is rotated by moving the circular arc part of the guide slot of the rotary guide plate along the fixed guide pin.

10

15

20

25

30

[0025] Figure 1 is the disassembled oblique view of probe card of the first embodiment of this invention. In Figure 1, the wiring circuit board 1 is the means to connect probe needle to the measurement device electrically. The upper guide plate 2 is the upside plate to guide the probe needle by the guide hole to pass through probe needle. The rotary guide plate 3 is the plate to rotate probe needle. The lower guide plate 4 is the lower-side plate to guide probe needle by guide hole to pass through probe needle. Probe needle 5 is the needle to conduct the electric signal by touching the pad on the wafer. The driving device 6 is the electromagnetic plunger or the motor to push the rotary guide plate. The guide slot 7 is the slot to guide the rotary guide plate. The fixed guide pin 8 is the pin to guide the rotary guide plate to move along the guide slot. Guide hole 12 is the hole to pass through probe needle.

[0026] Figure 2 is the side view of the initial condition of the probe card of the first embodiment of this invention. Figure 3 is the side view of the drive condition of the probe card. In Figure 3, wafer 9 is the semiconductor circuit board that the integrated circuit is formed. The pad 10 is the terminal for the connection of the signal and the power supply. The stage 11 is the base to raise and lower wafer put thereon. Figure 4 is the plan view of the rotary guide plate of the probe card and the illustrative figure of

6

rotation. Figure 5 is the side view of the probe card with stepped-stage in working.

[0027] The working of the probe card in the first embodiment of this invention as composed above is explained. First, the functional outline of the probe card is explained with referring to Figure 1. The upper guide plate 2 having guide hole 12 to guide the probe needle 5 is held horizontally fixedly between the top and the center of the probe needle 5. The rotary guide plate 3 having the guide hole 12 to guide the probe 10 needle 5 is held enabling to move horizontally in the center of the probe needle 5. The rotary guide plate 3 is held fixed temporarily in the initial position where the probe needle 5 becomes straight by the initial 15 position holding means. The lower guide plate 4 having the guide hole 12 to guide the probe needle 5 is held fixed horizontally between the center and the bottom of the probe needle 5. The probe needle 5 is connected to the wiring circuit board 1 electrically by contacting the top end of the probe needle to the board. The fixed 20 guide pin 8 is inserted into the guide slot 7 in the rotary guide plate 3 and the rotary guide plate 3 is held enabling to move in the position where the center of the probe needle 5 becomes bent. The tip of the 25 conductive straight probe needle 5 is moved to contact with the device under test. The driving device 6 moves the rotary guide plate 3 in the horizontal plane. The probe needle 5 may be rotated when the measurement starts, or may be rotated after every constant period. Or, it may be rotated automatically at any time 30 corresponding to the measurement condition.

[0028] The initial condition of the probe card is explained with referring to the figure 2. The upper guide plate 2, the rotary guide plate 3 and the bottom guide plate 4 are assembled so that the guide holes 12

to pass through the probe needle 5 are aligned in a line. The rotary guide plate 3 is fixed temporarily by the initial position holding means. In this condition, the straight probe needle 5 is passed through the guide hole 12. The side view of this condition is Figure 2.

5

10

[0029] The drive condition of the probe card is explained with referring to the figure 3. The fixation by the initial position holding means is canceled, and the rotary guide plate 3 is a little moved horizontally, and the probe needle 5 is made to bend. The fixed guide pin 8 is inserted into the guide slot 7 of the rotary guide plate 3 under this condition. The side view of this condition is shown in Figure 3.

[0030] The method to rotate the probe needle 5 15 with the rotary guide plate 3 is explained with referring to Figure 4. The driving device 6 pushes the rotary guide plate 3 in the bottom direction of Figure 4 (a). Then the rotary guide plate 3 moves in the bottom direction of Figure 4 (a) as the arc part of the 20 guide slot 7 is moving along the fixed guide pin 8. The driving device 6 is a means to generate the driving force by electromagnetic plunger or the motor. The driving device 6 may be another driving force generating means such as an air-cylinder or so. The arc 25 part of the guide slot 7 moves along the fixed guide pin 8. Then the rotary guide plate 3 moves as parallel sliding in its plane along the arc. The probe needle 5 rotates 1/3 - 1/4 turn. The central angle of the arc part of the guide slot 7 shown in Figure 4(a) is about 30 180 degrees. Then the rotary guide plate 3 is restricted to rotate 180 degrees. The rotary guide plate 3 can rotate 180-360 degrees if the form of the guide slot 7 and the driving force of the driving device 6 are chosen corresponding to the purpose.

[0031] Figure 4(a) shows the condition that the rotary guide plate 3 is in the middle position. The form of the guide slot 7 is a partial arc. Its central angle is chosen corresponding to the character and the number etc of the probe needle 5. As shown in Figure 4(b), the shape of the slot edge that the fixed guide pin 8 slides along should be arc. But the form of other part of the guide slot 7 may be any form with enough room for the fixed guide pin 8 to pass through. The form may be the half-disc, the sector or the full disc etc, not restricted to be crescent. The rotary angle of the probe needle 5 can be 360 degrees by setting up the form of the guide slot 7 and the driving device 6 suitably. The probe needle 5 can be rotated more than 360 degrees if the form of the guide slot 7 is a full disc. The rotation angle of the probe needle 5 can be set up freely corresponding to the purpose. At least two guide slots 7 are necessary. More than three guide slots 7 can be set up to enhance the precision of the movement. The rotary guide plate 3 might not move smoothly in some case of special shape of the guide slot 7. The force may be applied to the right or both sides of the rotary guide plate 3 to press in the central direction. The guide slot 7 may be composed of plastics with a little frictional coefficient or the solid lubricant. But, electrically conductive solid lubricant such as graphite is not suitable to use.

10

15

20

25

30

35

[0032] As shown in Figure 4(c), the probe needle 5 is rotated partially like a swing when the right-side arc of the guide slot 7 is moved along the fixed guide pin 8 by pushing the rotary guide plate 3 with the driving device 6. Figure 4(c) c-1 shows the state that the combined force of each driving force of the driving device 6 is applied to the rotary guide plate 3 from the bottom of the figure. It is the state that the

```
rotary guide plate 3 is moved most in the upward side
                   rotary guide plate 3 is moved most in the upward side the state that the state th
                                      of the figure of the from the ton and right of the driving device of the force of the from the ton and right of the driving device of the from the ton and right of the driving device of the from the ton and right of the driving force of the from the ton and right of the driving force of the from the ton and right of the driving force of the from the ton and right of the driving mide of the driving force o
                                                          driving guide plate 3 from the top and right of nier rotary guide plate 3 from the top rotary from the top and right of nier rotary guide plate 3 from the the rotary guide plate 3 from the rotary guide 3 fr
                                                                             rotary guide plate 3 from the top and right of the me or on figure.

figure.
                                                                                                 tigure. It is the downward side of the figure ain the downward side of the figure ain the downward shout an degree is moved in the rotated about 60 degree figure.
                                                                                                                    is moved in the downward side of the figure. The proper arisis needle in the that the downward side of the figure 4(c) c-3

The property of the figure 4(c) c-3

Arisis of the downward side of the figure 4(c) c-3

The property of the 
                                                                                                                                       needle 5 is rotated about 60 degrees. Figure 4(c) c-3

from the driving force of the driving force of the driving force of the driving force of the rotation dide niate 3 from shows the state that the rotation dide niate 3 from shows the state of the rotation dide niate 3 from shows the state of the rotation dide niate 3 from the rotation did not be action.
                                                                                                                                                           snows the state that the driving force of the driving from rotation guide plate 3 from rotation device 6 is applied to Trie roe erare that the firmers device 6 is applied to the firmers are the row of the row of the firmers are the row of the 
                                                                                                                                                                                 device 6 is applied to the rotation guide plate 3 from the rotary that the rotary of the figure. It is the animular acide of the figure moved most in the animular acide of the top of the moved most in the animular acide of the moved most in the animular acide of the top of the moved most in the animular acide of the top of the moved most in the animular acide of the top of the moved most in the animular acide of the top of the moved most in the animular acide of the top of the moved most in the animular acide of the top of the moved moved moved the top of the top of the moved moved the top of the top of the top of the moved moved the top of 
                                                                                                                                                                                                     the top of the figure. It is the downward side of the guide plate a nrobe needle side rotated about 120
                                                                                                                                                                                                                        guide plate 3 is moved most in the downward side figure. The probe needle 5 is rotated about 120
                                                                                                                                                                                                                                        tigure. The prope needle 5 ls rotated about that the degrees. Figure 4(c) and the degrees.
                                                                                                                                                                                                                                                            degrees. Figure 4(c) c-4 shows the state that the the driving device 6 is applied to the driving device and right of the from the ton and right of the driving arithmeter and right of the from the ton and right of the driving arithmeters.
                                                                                                                                                                                                                                                                                   driving torce of the driving device b is applied to of the driving device b is applied to the and right of the arrival are to and right of niare to arrival ar
                                                                                                                                                                                                                                                                                                      rotary guide plate 3 trom the top and right of the state that the rotary fimire figure. half in the inner and aide of the fimire figure.
                                                                                                                                                                                                                                                                                                                         tigure. It is the state that the rotary guide plate 3

tigure. It is the upward side of the driving force of the returns half in the atoto that the driving force of the returns and the state that the driving force of th
                                                                                                                                                                                                                                                                                                                                             returns half in the state that the rotary mide nlate that the rotary mide annivers 4(c) c-5 shows
                                                                                                                                                                                                                                                                                                                                                                4(c) c-b snows the state that the the rotary guide plate that the rotary guide that the driving device 6 is applied to the real of the fimite of the finite of the fimite of the finite of the fimite of the finite 
                                                                                                                                                                                                                                                                                                                                                                                       ariving device b is applied to the rotary guide plate 3 of the figure. It is the universal eight of the figure what in the universal eight of the figure what is the state of the eight of the figure when the eight of the
                                                                                                          10
                                                                                                                                                                                                                                                                                                                                                                                                       trom the bottom of the figure. It is the upward side of rotary guide one or the reservoir rotary fimite one or the fimite of the chime the chime
                                                                                                                                                                                                                                                                                                                                                                                                                          rotary guide plate 3 returns most in the upward the swing rotation of the the swing rotation of the the figure. One cycle of the in his war, which was the figure.
                                                                                                                                                                                                                                                                                                                                                                                                                                           the figure. One cycle of the swing rotation or the the figure. One cycle of the swing rotation of the swing rotation of the the swing rotation of the the swing rotation of the 
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ited as much as necessary. the swing rotation can need to the swing rotation read to the swing rotation read to the swing rotation can need to the swing ro
                                                                                                                                                                                                               15
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     luuyy In this prope card, the swing rotation can the swing rotation can the swing rotation needle swith the prope read raised times with the prope raised in necessary times with the proper raised in necessary times wit
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           be repeated any necessary times with the probe needle is raised in of the wafer 9. The raise on the pad 10 of the wafer searches the raise on the pad 10 or one needle with the probe needle in the probe needle with the probe needle with the probe needle in the problem needle in
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               on the pad 10 of the water y. The stage 11 15 raised the pad 10 of the water y. The stage 11 15 raised the pad 10 of the all the pad 10 of the needle 5 reaches and then the probe needle needle needle and then and then after affect, or the needle needle the probe needle needl
                                                                                                                                                                                                                                                                                                                                                                                                                                                                    repeated as much as necessary.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      and then the every probe needles the radio to rate and then the every probe needles the radio to rate wafer 9. After the driving device the radio to rate the radio to rate the radio to rate to rate to radio to rate to radio to rate to radio to rate t
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         the pad 10, the driving device 6 pegins not rotated even the pad 10, the driving probe needle 5 is not in while the probe needles 5. The probe reached the nad 10 while the probe needles 5.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             probe needles 5. The probe needle 5 is not rotated 6

probe needles 5. The probe sthe pad 10 while the first the probe needle 5 reaches the pad 10 while the first the probe needle 5 reaches the pad 10 while the first the probe needle 5 is not rotated 6.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           y is rising. Quide plate 3 bends the straight marafore the interval 11/10 marafore the interval
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                luusal the straight merefore, the interval probe needle 5 only a little.
                                                                                                                                                                                                                                                                                                                                                                                                                    25
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             wafer 9 is rising.
```

b

of the probe needles can be made small comparing to the case that the center of the probe needle 5 is curved. The diameter of the probe needle 5 is about 50~100 microns. The pitch of the needles is more than about 80 microns. The bend of the probe needle 5 is about 0.5mm. These numerical values are the examples of the typical value. Even other numerical values except for these values can be applied to the embodiments.

5

10

15

20

25

30

35

[0035] As for processing of the probe needle 5, the needlepoint is trimmed and the length is managed strictly. No extra processing such as to form a curving part is not performed. Therefore, the dispersion of the form and the elasticity of the probe needle 5 can be restrained, and the needle pressure can be uniform. The probe needle 5 reaches perpendicular the pad 10 or the vamp and it only rotates like swinging quickly. Because the probe needle 5 does not scribe the pad 10, even if the pad 10 is damaged, the size of the scratch is less than the diameter of the needle. Comparing to scribing, the oxide trash hardly sticks to the needlepoint. The probe needle 5 is made of tungsten typically. Other metals of the quality are available. The shape of the needlepoint may be conic. The needlepoint of the triangular or square pyramid can break through the oxide film effectively. The oxides on the surface of the pad 10 are  $Al_2O_3$  or  $SiO_2$  typically. The oxide of the organic solvent accumulates on the surface of the pad 10 and becomes an insulator layer as well. This insulator layer can be broken through in the same way.

[0036] As shown in Figure 5, the rotary guide plate 3 has a stepped-stage. The shape of the rotary guide plate 3 is made to be the skip-floor form. Even if the needle diameter of the probe needle 5 is different, it is possible to adjust the needle pressure uniform. When the probe needle 5 is bent with the

rotary guide plate 3 dislocated, even if the bend of the probe needle 5 is the same, the elasticity coefficient (spring constant) of the probe needle 5 becomes different because the deflection angle of the probe needle 5 is different according to the height of the rotary guide plate 3. The elasticity coefficient of the thick probe needle is large basically. The needle pressure of the thick probe needle can be adjusted to become the same as of the thin probe needle by bending 10 the thick probe needle so that the elasticity coefficient may become relatively small. And also it is possible that the needle pressure of the different diameter needle is made the same as the needle pressure of other probe needles by shifting the position of the guide hole of the rotary guide plate 3 to pass through 15 the probe needle 5. In this case, assembling becomes a little difficult because the probe needle 5 is bent in the state shown in Figure 2.

[0037] As explained above, in the first embodiment 20 of the present invention, the probe card is comprised as follows. The straight probe needle is inserted through the upper guide plate, the rotary guide plate and the lower guide plate, the center of probe needle is bent by moving the rotary guide plate in the 25 horizontal direction and the probe needle is rotated by moving the circular arc part of the guide slot of the rotary guide plate along the fixed guide pin. Therefore, the needle pressure becomes uniform. The scratch by the probe needle is smaller than the needle 30 diameter. The measurement can be done without damaging the pad of the wafer. The pad is not damaged unnecessarily because no scribing damages the pad and no scratch beyond the needle diameter damages the pad.

[0038] The second embodiment of the present invention is the probe card, wherein the straight probe

```
needle is inserted through the upper guide plate, the
                       needle 15 inserted through the lower guide plate, the rotary guide plate and the hoar m. A. and a rotary of manh many in hoar m.
                                               rotary guide plate and the lower guide plate the rotary of probe needle is bent by displacing aircraft center of probe needle is the rotary displaced aircraft aircraft.
                                                                       center or prope needle in the horizontal direction and the horizontal dire
                                                                                           rotating guide plate in the norizontal direction and the rotary inserted in the probability rotating inserted in the probability rotating inserted in the probability residence around the probability are probability around the pro
                                                                                                                       the prope needle is rotated by rotating inserted in the fixed guide pin name of the plate around in the rotary mide of the plate of the plate of the property of the plate of the plate of the property of the plate of the property of t
                                                                                                                                                                                                                                                                                              attic nearing in the rotary guide place.

(0039) Figure 6(a) is the disassembled oblique

(0039) Figure 6 or the earth amount of the
                                                                                                                                                   yulue place around in the rotary guide plate.

eccentric hearing rimer rich in the rotary aircommical
                                                                                                                                                                                           (10039) Figure 6(a) is the disassembled oblique embodiment of this second embodiment of the seco
                                                                                                                                                                                                                  View of probe card of the second embodiment of this is the cross section of the second embodiment of this is the cross section of invention.
                                                                                                                                                                                                                                          invention. The figure 6(b) is the cross section of late to invention. The figure 6. In Figure 6, anide plate to eccentric bearing 14. In the rotary anide plate to eccentric bearing to anide the rotary anide plate to eccentric bearing to anide the rotary anide plate to eccentric bearing to anide the rotary anide plate to eccentric bearing to anide the rotary anide plate to eccentric bearing to anide the rotary anide plate to eccentric bearing to anide the rotary anide plate to eccentric bearing 14.
                                                                                                                                                                                                                                                                  eccentric bearing to guide the rotary guide plate to is the bearing to make the rotary guide the rotary guide to a make the rotary guide plate to a make the rotary guide the rotary guide to a make the rotary guide to a make the rotary guide the 
                                                                                                                                                                                                                                                                                          is the hearing to guide the rotary guide pin 8 is the guide the rotary guide pin 8 is the the the start the fixed guide pin 14 to rotate the fixed hearing 14 to rotate the rotate in the plane.
                                                                                                                                                                                                                                                                                                              rotate in the plane. The fixed guide pin y is the guide the rotate in the plane. The fixed pearing 14 to rotate for the eccentric bearing nin heing deviated to the eccentric pin inserted to the in the niane. The nin heing deviated pin inserted to the in the niane.
                                                                                                                                                                                                                                                                                                                                      pin inserted to the eccentric bearing la to rotate the pin heing deviated the plane, of the hearing. The pin hearing me the plane, of the hearing.
                                       5
                                                                                                                                                                                                                                                                                                                                                                  rotary guide plate in the plane, the paring me rotary guide plate in the rotation of the bearing?
                                                                                                                                                                                                                                                                                                                                                                                      trom the center poard 1, the horrow mide nigre 1 the horrow mide nigre 3 the wiring mide nigre 3 the horrow mide nigre 1 the horrow mide nigre 1 the horrow mide nigre 3 the horrow mide nigre 4 the horrow mide nigre 5 the horrow mide nigre 6 the h
                                                                                                                                                                                                                                                                                                                                                                                                                 wiring circuit board 1, the upper guide plate 4, the wiring circuit board 1, the bottom guide rhe mide hole rotary guide plate 3, the bottom device 6, the mide hole rotary needle 5, the driving device 6, the mide hole rotary needle 5, the driving device 6, the mide hole rotary needle 5, the driving device 6, the mide hole rotary needle 5, the driving device 6, the mide hole rotary needle 5, the driving device 6, the mide hole rotary needle 5, the driving device 6, the mide hole rotary needle 5, the driving device 6, the mide hole rotary needle 6, the driving device 6, the mide hole rotary needle 6, the driving device 6, the mide hole rotary needle 6, the driving device 6, the mide hole rotary needle 6, the driving device 6, the mide hole rotary needle 6, the driving device 6, the mide hole rotary needle 6, the driving device 6, the driving device
                                                                                                                                                                                                                                                                                                                                                                                                                                     rotary guide plate 3, the driving device 6, Figures 7(a), the probe needle 5, the first embodiment. Figures as the first embodiment.
                                                                                                                                                                                                                                                                                                                                                                                                                                                             probe needle by the first embodiment. Figures not and the first embodiment the first embodiment are the same as the the niam view of the same are the same arow the niam view of the same are the same are the same are the same arow the niam view of the same are the same are the same arow the niam view of the same are the same arow the niam view of the same are the same arow the niam view of the same are the
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     are the same as the first embodiment. Figures 7(a) and 7(c) show the plan view illustration from 7(b) and 7(c) are reasonable from 1100 and 1100 are reasonable from 1200 a
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         T(D) and T(C) show the plan view illustrative figure of plate of the probe card and the plate of the plate 
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ion. The working of the probe card in the second in the se
                                                                                                                                                                                                                                                  15
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    (UU4U) The working of the property of this invention as composed above is embodiment of this invention as composed above of this invention of the arche of the ar
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            embodiment of this invention as composed above is card working of the probe card working of the first embodiment of this invential working of the probe card embodiment of this invential working of the probe card embodiment of this invential working of the probe card embodiment of this invential working of the probe card embodiment of this invential working of the probe card embodiment of this invential working of the first embodiment of the fundamental working of the first embodiment of the fundamental working as the first embodiment of the fundamental working of the first embodiment of the fundamental working as the first embodiment of the first embodiment of the fundamental working as the first embodiment of the fundamental working as the first embodiment of the fundamental working as the first embodiment of the first embodiment of
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        shown in Figure 6(a) is the same as the first into the shown in Figure 6(a) is the same as the first into the shown in Figure 6(a) is the same as the first into the shown in Figure 6(a) is the same as the first into the shown in Figure 6(a) is the same as the first into the shown in Figure 6(a) is the same as the first into the shown in Figure 6(a) is the same as the first into the same as the first into the shown in Figure 6(a) is the same as the first into the shown in Figure 6(a) is the same as the first into the same as the 
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    explained. The fundamental wolkling of the first incorrect shown in Figure 6(a) is the same as the incorrect shown in Figure 54.000 mide vin a ic incorrect shown in Figure 54.000 mide vin a ic incorrect shown in Figure 54.000 mide vin a ic incorrect shown in Figure 54.000 mide vin a ic incorrect shown in Figure 54.000 mide vin a ic incorrect shown in the first shown in th
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    embodiment. The fixed guide pin 8 is inserted into the rotary guide plate 3. In the rotary guide plate anahim to the eccentric bearing 14 in the rotary are held enahim to the eccentric has rotary mide his nate 3 is held enahim to the eccentric has rotary mide his mister and the rotary mide his mide his mister and the rotary mide his 
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            eccentric bearing 14 in the rotary guide plate 3. In to enter of the rotary guide plate 3 is held enabling to this way, the rocition where the rotary guide plate 3. In the rotary guide pl
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     rotation.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            the rotary guide plate 3 is held enabling the probe the center of the probe where the center of the probe move in the position where the center of the position where the center of the position who the probability of the position who the position who the probability of the probability of the position where the probability of the probability of
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    move in the position where the center of the conductive needle secones bent.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               needle becomes needle ariming dering the straight probe needle ariming dering the straight problem that the straight problem is a straight pr
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   straight probe needle b is moved to contact with the straight probe needle b is moved device 6 moves the driving device under test. in the north or and all device under the driving device of the dri
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     25
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           uevice under test. The uriving device o moves a in the horizontal plane.

Totary guide plate 3 in the horizontal plane.
```

[0041] As shown in Figure 6(b), the eccentric bearing 14 is made to insert the fixed guide pin 8 into the hole deviated from the center of the usual bearing such as a ball bearing or a roller bearing. The eccentric bearing 14 may be composed of the simple frictional bearing. The outside diameter of the eccentric bearing 14 is 1mm, for example. The distance between the rotation center of the eccentric bearing 14 and the axis of the fixed guide pin 8 are 0.8mm, for example. The eccentric bearing 14 is set up in the rotary guide plate 3, and the fixed guide pin 8 is inserted into the eccentric bearing 14. Both ends of the fixed guide pin 8 are fixed on the upper guide plate 2 and the bottom guide plate 4 respectively.

10

15

20

25

30

35

[0042] The method to rotate the probe needle 5 with the rotary guide plate 3 is explained with referring to Figure 7(a)-7(c). The driving device 6 pushes the rotary guide plate 3 in the bottom direction of Figure 7(a), and the rotary guide plate 3 rotates around the fixed guide pin 8 inserted in the eccentric bearing 14, then the rotary guide plate 3 moves in the bottom direction of Figure 7(a). The eccentric bearing 14 rotates around the fixed guide pin 8, and also the rotary guide plate 3 moves along an arc, then the probe needle 5 rotates. The driving device 6 pushes the rotary guide plate 3 in all the directions in order. Then, as shown in Figure 7(b), the rotary guide plate 3 rotates at 360 degrees. And, the driving device 6 pushes the rotary guide plate 3 in the specific angle, then, as shown in Figure 7(c), the rotary guide plate 3 swings in the angle of about 90 degrees.

[0043] As explained above, in the second embodiment of the present invention, the probe card is comprised as follows. The straight probe needle is inserted through the upper guide plate, the rotary

guide plate and the lower guide plate, the center of probe needle is bent by displacing the rotary guide plate in the horizontal direction and the probe needle is rotated by rotating the rotary guide plate around the fixed guide pin inserted in the offset bearing in the rotary guide plate. Therefore, the probe needle can rotate smoothly.

[0044] The third embodiment of the present invention is the probe card, wherein the straight probe needle is inserted through the upper guide plate, the rotary guide plate and the lower guide plate, the center of probe needle is bent by displacing the rotary guide plate in the horizontal direction and the probe needle is rotated by rotating the rotary guide plate around the fixed guide pin fixed in the rotary guide plate and inserted in the eccentric bearing in the upper and lower guide plates.

[0045] Figure 8(a) is the disassembled oblique view of probe card of the third embodiment of this invention. The figure 8(b) is the cross section of eccentric bearing 14. In Figure 8, eccentric bearing 14 is the bearing to guide the rotary guide plate to rotate in the plane. The fixed guide pin 8 is the guide pin fixed in the rotary guide pin and inserted in the eccentric bearing 14 to rotate the rotary guide plate in the plane, the pin being deviated from the center of the rotation of the bearing. The wiring circuit board 1, the upper guide plate 2, the rotation guide plate 3, the bottom guide plate 4, the probe needle 5, the drive device 6, the guide hole 12 are the same as the first embodiment.

[0046] The working of the probe card in the third embodiment of this invention as composed above is explained. The fundamental working of the probe card shown in Figure 8(a) is the same as the first

embodiment. The fixed guide pin 8 is inserted into the eccentric bearing 14 in the upper and lower guide plates 2,4 and fixed in the rotary guide plate 3. In this way, the rotary guide plate 3 is held enabling to move in the position where the center of the probe needle 5 becomes bent. The tip of the conductive straight probe needle 5 is moved to contact with the device under test. The driving device 6 moves the rotary guide plate 3 in the horizontal plane.

[0047] The method to rotate the probe needle 5 with the rotary guide plate 3 is about the same as the second embodiment. The driving device 6 pushes the rotary guide plate 3, and the fixed guide pin 8 fixed on the rotary guide plate 3 moves. Due to the rotation of the eccentric bearing 14 in the upper guide plate 2 and the bottom guide plate 4, the fixed guide pin 8 moves along an arc. The rotary guide plate 3 moves along the arc. Then, the probe needle rotates.

[0048] As explained above, in the third embodiment of the present invention, the probe card is comprised as follows. The straight probe needle is inserted through the upper guide plate, the rotary guide plate and the lower guide plate, the center of probe needle is bent by displacing the rotating guide plate in the horizontal direction and the probe needle is rotated by rotating the rotary guide plate around the fixed guide pin fixed in the rotary guide plate and inserted in the eccentric bearing in the upper and lower guide plates. Therefore, the probe needle can rotate smoothly.

[0049] While a preferred embodiment of the present invention has been shown and described, it will be apparent to those skilled in the art that many changes and modifications may be made without departing from the invention in its broader aspects. The appended claims are therefore intended to cover all such changes

and modifications as fall within the true spirit and scope of the invention.